TECHNICAL MANUAL

Model: SURVEYOR M
Portable Count-Rate Meter

Manual Part No. 1029900

BICRON

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1.0 General Description

The Bicron SURVEYOR M is a versatile, portable count-rate meter used for the detection and measurement of ionizing radiation when equipped with an appropriate GM or scintillation probe. Its front panel HV adjustment with readout on the meter enables the user to interchange GM and scintillation detectors with ease.

The unit features a recessed meter movement, single ON-OFF range selector switch, MHV probe connector, mounted probe holder, front-panel high voltage adjustment, switch-selectable response time, and built-in audio.

1.1 SPECIFICATIONS

RADIATION DETECTED: Alpha, beta, gamma, and X-ray depending upon detector used

RANGE: Four linear ranges of 0-1,000, 0-10,000, 0-100,000 and 0-1,000,000 CPM

ACCURACY: Within 10% of reading between 20% and 100% of full scale on any range

DETECTOR: Choice of GM and scintillation probes

HIGH VOLTAGE: Electronically stabilized, adjustable to at least 1600V with readout on the meter

CONNECTOR: MHV

WARMUP TIME: None

SATURATION: When switch-selectable, anti-saturation circuit is activated, typically >1000 R/h on the X1, X10, and X100 ranges - for most GM probes; >5 R/h for pancake GM detectors

RESPONSE TIME: Switch-selectable, optimized for each range, 0-90% of final reading as follows:

Range	Time	
	Fast	Slow
X1	12 sec.	20 sec.
X10	1 sec.	8 sec.
X100	<1 sec.	2 sec
X1000	<1 sec.	1 sec.

TEMPERATURE: operational from -20° to +50°C

HUMIDITY: <5% change in reading from 10-95% RH

CONTROLS: Seven-position rotary switch-off, bat., HV, X1000, X100, X10, X1; rotary audio and response switches; protected, rotary HV adjustment control

BATTERY LIFE: Typically 100 hours (200 hours with parallel option) for GM probes in normal background, and 50 hours (100 hours with parallel option) for scintillation probes: use of audio may reduce battery life to less than these values.

DISPLAY: Ruggedized, recessed, high-torque 1 mA meter with 3.35 inch (8.51 cm) scale marked 0-1000 counts per minute and 0-2.0 kilovolts, with bat. ok, band. Meter protected by impact resistant Lexan ® polycarbonate window

GEOTROPISM: Within +/-2% of full scale

SHOCK: 100g per lightweight machine of MIL-STD 202C, method 202B

VIBRATION: 5g in each of three mutually orthogonal axes at one or more frequencies from 10-33Hz

CONSTRUCTION: Splash-proof, shock proof, two-piece all-metal case; scratch-resistant laminated control panel and Bicron Kleen-Krome ® trim on case top; durable black polyurethane paint on handle and case bottom; stainless steel probe clip

AUDIO: A built-in speaker, with panel mounted ON-OFF switch, provides audible "click" for each detector pulse. With the speaker OFF, an audible alarm sounds (if desired) when meter is > full scale on any range

SIZE: 4.25 X 8 X 6.8" including handles and probe clip (10.8 X 20.3 X 17.3cm)

WEIGHT: 2.2 lbs. (1 kg), excluding probe

2.0 BATTERY INSTALLATION

BATTERY TYPE: 9-volt Mallory MN 1604 or equivalent.

PROCEDURE:

1. Turn instrument off.
2. Open pull catches at ends of case and separate case bottom from top.
3. Install battery in appropriate clip on bottom circuit board (clip for spare battery is so marked), observing proper polarity.
4. Replace bottom orienting rubber pad under battery; close catches.

PARALLEL-WIRED OPTION: Instruments with this option have both battery clips wired into the circuit. Installing a second battery thus provides twice the operational hours of one battery. Only one battery is needed to power the instrument, however.

2.1 BATTERY TEST

Turn control switch to the "bat". position; a meter reading within the "bat. OK" checkband should be observed.

This test allows monitoring of the condition of the battery.

2.2 HIGH VOLTAGE MEASUREMENT

Turn control switch to the "HV" position. Detector high voltage is directly displayed on the lower meter scale.

3.0 SET UP

Both GM and scintillation probes can be used with the SURVEYOR M. The choice of detector determines which set up procedure should be followed.

3.1 GM PROBES

Set up for GM probes requires that the HV be set (usually to 900V) before the probe is connected to the instrument (see Section 3.3 for further details on HV adjustment). In addition, you must activate the anti-saturation circuit by turning ON its internally-mounted switch (see sections 3.4 and 3.5).

****CAUTION****

Do not use the X1000 range with GM probes. Erroneous readings may result.

Do not exceed the GM probe's maximum HV rating.

3.2 SCINTILLATION PROBES

Set up for scintillation probes requires the anti-saturation circuit be turned OFF (see section 3.5) and the HV appropriate to the application first be determined. To determine this HV setting:

1. Turn the response switch to "fast".
2. Place a small reference source, of the type to be measured, near the window of the probe, in a fixed geometry.
3. Set the HV to zero (see Section 3.3).
4. With the instrument on one of its counting ranges, slowly increase the HV setting until counting begins.
5. Switch to HV and note the voltage.
6. Increase the HV by 100 volts.
7. Switch to an appropriate counting range and note the counting rate.
8. Repeating steps 5, 6, and 7 will yield data which should indicate a region where the counting rate remains relatively constant when the HV is varied +/-50 volts or so (counting rate plateau).
9. Once this has been found, record the counting rate and the HV setting for future reference.

****CAUTION****

Do not exceed the scintillation probe's maximum HV rating.

3.3 DEADTIME COMPENSATION SWITCH

This internally-mounted, on-off switch (located near the 24 pin connector on the main PC board) should be left in the ON position. The circuit activated by the switch only compensates for the deadtime in the instrument's circuitry, not for detector deadtime. This switch is intended for a future use.

3.4 HV ADJUSTMENT

This front panel control provides an easy adjustment for the detector high voltage. The actual HV setting is read on the meter scale when the selector switch is in the HV position (Section 2.2).

Clockwise rotation of this control increases the HV, while counterclockwise rotation decreases it. It may take a few seconds for the HV to decrease following a counterclockwise adjustment.

The normal factory HV setting is 900V.

****CAUTION****

An HV setting in excess of the maximum HV specified for the probe being used may cause damage to the probe!

3.5 ANTI-SATURATION CIRCUIT

This circuit protects against the effects of GM tube saturation (overrange fold-back) and always should be activated when using GM probes. The circuit will keep the meter reading beyond full-scale when saturation is produced (see SATURATION specification).

Conversely, leaving the circuit activated when using scintillation probes may produce false readings; i.e., the instrument may act as if the detector is in saturation (the probe's voltage divider may engage the circuit erroneously) when, in fact, it is not.

An internally-mounted switch (located near the center of the main PC board) activates (ON) or deactivates (OFF) the anti-saturation circuit.

4.0 OPERATION

To make a radiation measurement:

1. Check the HV setting (Section 2.2) and connect the probe.
2. Select the appropriate audio (Section 4.1.), response time (Section 4.2) and counting range settings.
3. Perform the survey, making sure to multiply the meter reading by the counting range setting to obtain the reading in counts per minute.

Note: When using GM probes, select only the X1, X10, or X100 counting range; do not use the X1000 range. Any of the four ranges may be selected when using scintillation probes.

4.1 AUDIO:

An internal speaker will produce an audible click for each detector pulse. This speaker is controlled by a panel mounted ON-OFF switch labelled "audio".

An audible alarm will sound when the meter is approximately 30% or more above full scale on any range.

The over-range alarm will function only when the panel mounted "audio" control is in the OFF position. When the audio control is in the ON position, the over-range alarm is defeated.

The over-range alarm can be defeated by turning the internal alarm ON-OFF switch OFF. See Section 4.3 for more details.

4.2 SELECTABLE RESPONSE TIME

In addition to the built-in circuitry which optimizes response time for each range, a front panel switch labelled "response fast-slow" may be used to tailor response time to the survey situation.

5.0 CIRCUIT DESCRIPTION

The electronic circuitry in the Bicron SURVEYOR M with Digital Scaler Option is contained on four, interconnected, printed circuit boards. Modern solid-state integrated circuitry is used throughout. The major components are:

1. High-voltage power supply. This is a feedback-regulated, electronically stabilized supply for the detector potential. Additional circuitry provides HV readout on the meter scale.
2. Count-rate meter. A linear charge pump rateme-ter converts the detector pulses to a count rate reading on the calibrated meter scale. The circuitry includes a unique resolving time com-pensation technique to provide linear response over the full range, with both scintillation and GM probes, automatic and manual time constant selection, and temperature compensation.
3. Audio circuitry for individual pulse counting and overrange alarm.
4. Anti-saturation circuitry which forces the meter beyond full scale in high radiation fields.

6.0 CALIBRATION

The SURVEYOR M, being a count rate instrument, is normally calibrated electronically in counts per minute.

Electronic calibration involves connecting the unit to a variable frequency pulse generator, which is then set at the frequencies needed to produce 80% and 20% of full scale meter readings (cpm) for each range. Calibration controls are set for 80% of full scale readings, and linearity is checked by going to the 20% readings.

Detailed calibration procedures are part of the Q.C. Acceptance Procedure found elsewhere in this manual.

BICRON QC ACCEPTANCE PROCEDURE NUMBER 1029930

MODEL: SURVEYOR M

1. Perform a visual inspection of finished product.

2. Remove all 9V batteries and connect a 9.30V+/- .05V power source across the main battery terminals on the battery board. Perform the following calibrations:

   a. Turn the control switch to "OFF". Mechanically zero the meter via the rear zero adjustment screw on the meter barrel.

   b. Turn the control switch to "X1000". Check the +5V supply at pin 1 of U6 (ICL 7663). The reading should be 5VDC +/-10%.

   c. Leave the control switch set at "X1000" and connect a voltmeter between pins 1 (ground) and 15 of the 24 pin connector. Adjust R31 (50 kohm zero pot) until the voltmeter reads 1 mVDC+2 1/2/-1. Check the voltage reading on the "X100", "X10", and "X1" ranges. Little change should occur.

   d. Turn the control switch to "HV" and connect a high voltage measuring device with an impedance $\geq$1000 megohoms to the probe connector center pin. Adjust the high voltage supply to +1000 VDC +/-3% via the front panel control.

   e. Leave the control switch set at "HV" and adjust R29 (500 ohm span pot) until the meter reads 1.0KV. To test linearity, increase HV to +1600V. The meter should read 1.6KV+/-5%. Decrease HV to +400V. The meter should read .4KV+/-5%.

   f. Perform a CPM calibration.

      1) Turn the anti-saturation circuit switch to ON and the control switch to "X1000".

      2) Connect a variable frequency pulse generator to test point 2 (pin 5 of the 24 pin connector) and adjust the frequency of the pulse generator to the value (listed in Table T-1) needed to calibrate the unit at 80% of full scale on the meter.

      3) Adjust R21 (the 5 Kohm, X1000 calibration pot) until the meter reads 80% of full scale.

      4) Readjust the frequency to the value needed to calibrate at 20% of full scale (also in Table T-1).

      5) Note the meter readings from steps 3) and 4) on a Certificate of Calibration.

      6) Similarly, calibrate the X100 range, using R19 (the 50 Kohm, X100 calibration pot); the X10 range, using R17 (the 500 Kohm, X10 calibration pot); and the X1 range, using R15 (the 5 megohm, X1 calibration pot).

      7) Leave the pulse generator connected when calibration is complete.

TABLE T-1

Range	Pulse Generator Output (Hz)	Actual cpm	Acceptable Meter Reading (cpm)
X1000 (80%)	11,110	800,000	720,000 - 880,000
X1000 (20%)	3,175	200,000	180,000 - 220,000
X100 (80%)	1,310	80,000	72,000 - 88,000
X100 (20%)	330	20,000	18,000 - 22,000
X10 (80%)	133	8,000	7,200 - 8,800
X10 (20%)	33	2,000	1,800 - 2,200
X1 (80%)	13.3	800	720 - 880
X1 (20%)	3.33	200	180 - 220

Note: The values in the above tables may not correspond to those for other Bicron or competitive models.

g. Mark all trimpot bodies in such a way as to show the general position of the adjustment screws after calibration.

3. Turn the response switch to "fast" and the control switch to "X1000". Vary the frequency of the pulse generator to obtain a reading near full scale and switch between "fast" and "slow" to check the operation of the response switch. Do the same for the "X100", "X10", and "X1" ranges. Leave the pulse generator connected.

4. Test the audio as follows:

a. Turn the audio switch to "on" and check to see that the audio functions properly on all four counting ranges, using the pulse generator. Also, check that the audio remains silent when the selector switch is on "bat." and "HV".

b. Turn the audio switch to "OFF" and SW3 (alarm ON/OFF switch) on the main PC board to "ON". Drive the meter well beyond full scale with the pulse generator and observe that a continuous tone is heard. Do this on all four counting ranges.

c. Disconnect the pulse generator.

5. Turn the control switch to "HV" and adjust the HV to +900 VDC via the front panel control. Test the anti-saturation circuit, as follows:

a. Turn the control switch to the "X1000" position and connect a 500 megohm resistor across the probe connector (from +900V to ground). The meter should peg beyond full scale.

b. Replace the 500 megohm resistor with a 2000 megohm resistor. The meter should remain at zero. Remove the 2000 megohm resistor and leave the HV set a +900 VDC unless otherwise specified.

6. Remove all test equipment. Turn the instrument OFF and install a new +9V battery in the appropriate battery holder (either holder may be used when holders are parallel-wired).

7. Attach a probe to the instrument, observing the proper HV precautions. Place the probe near an appropriate check source and turn the selector switch to each of the four ranges in turn. A meter reading should be obtained for each range.

8. Complete, date, and sign a Certificate of Calibration.

SPARE PARTS LIST SURVEYOR M

SCHEMATIC SYMBOL	DESCRIPTION				PART NO
	Main PC Board Assembly				**1029010**
C1, C22	Capacitor,	0.1uF	Film		9211041
C2, C18, C19	Capacitor,	.001 uF,	3kV cer.		9201022
C3	Capacitor,	.001 uF,	Film		9211021
C5, C20	Capacitor,	33 uF,	10 V tan.		9233361
C6, C7, C23	Capacitor,	.01 uF,	Film		9211031
C8	Capacitor,	2.2 uF,	16 V tan.		9232251
C9, C25	Capacitor,	1.0 uF,	35 V tan.		9231051
C10, C13, C17	Capacitor,	.22 uF,	Film		9212241
C11, C12, C21, C24	Capacitor,	.047 uF,	Film		9214731
C14	Capacitor,	180 pf,			9201811
C15, C16	Capacitor,	.01 uF,	3 kV cer.		9201032
D1, D2, D4-D10, D13-D17, D20	Diode,	1N4148			9600004
D11, D12	Rectifier,	2 kV PIV			9600001
Q1	Transistor,	2N4124			9610001
Q2	Transistor,	2N5210			9610005
Q3	Transistor,	2N4126			9610002
R1	Resistor,	10k,	1/4w	5%	8110022
R2	Resistor,	200 ohm,	1/4w	5%	8120002
R3	Resistor,	27k,	1/4w	5%	8127024
R4	Resistor,	1.3k,	1/4w	5%	8113012
R5	Resistor,	4.7k,	1/4w	5%	8147012
R6, R56, R57	Resistor,	10k,	1/4w	5%	8110024
R7, R8	Resistor,	4.7k,	1/4w	5%	8147014
R9	Resistor,	10k,	1/4w	1%	8510024
R11, R12, R22	Resistor,	100k,	1/4w	5%	8110034
R13, R50	Resistor,	274k,	1/4w	1%	8527434
R14	Resistor,	4.99 meg,	1/4w	1%	8549941
R15	Trimpot,	5 meg,			9395051
R16, R38	Resistor,	499k,	1/4w	1%	8549934
R17	Trimpot,	500k,			9395041
R18, R39	Resistor,	100k,	1/4w	1%	8549924
R19, R31	Trimpot,	50k			9395031
R20, R27	Resistor,	4.99k,	1/4w	1%	8549914
R21	Trimpot,	5k,			9395021
R23,R34-R36,R41, R55, R58	Resistor,	1 meg,	1/4w	5%	8110044
R24, R40, R44, R54	Resistor,	470k,	1/4w	5%	8147034
R28, R46	Resistor,	82.5k,	1/4w	1%	8582524
R29	Trimpot,	500 ohm,			9395011
R30	Resistor,	249 ohm,	1/4w	1%	8524904
R32	Resistor,	1 meg,	1/4w	1%	8510044
R33	Resistor,	11k,	1/4w	1%	8511024
R37	Resistor,	1000 meg,	1%		8810071
R42	Resistor,	1k,	1/4w	5%	8110014
R43	Resistor,	2.7k,	1/4w	5%	8127014
R47, R51, R52	Resistor,	3.3meg,	1/4w	5%	8133044
R48	Resistor,	100k,	1/4w	1%	8510034
R49	Resistor,	23.7k,	1/4w	1%	8523724
RN1	Res. Network,	7 X 220k			8822031

SW3, SW6, SW7	Switch.	Slide, SPST		9550001
U1	Int. Ckt.,	MC3302PDS		9640002
U2	Int. Ckt.,	MC14538BCPDS		9650004
U3	Int. Ckt.,	MC14093BCPDS		9650001
U4, U5	Int. Ckt.,	CA3160BEX		9640001
U6	Int. Ckt.,	CL7663CPA		9640003
U7, U8	Int. Ckt.,	CD4016BEX		9650002
XFMR	Transformer,	M8149		9500001
	Connector,	24—pin		9780001

Switch PC Board Assembly

1029020

R26	Resistor,	681 ohm,	1/4w 1%	8568104
SW2, SW4	Switch,	Rotary,	2 pos.	9560003
SW5	Switch,	Rotary,	2-7 pos.	9560001
	Sounder			9720001
	Header,	24—pin		9780002

Battery PC Board Subassembly **9420001**

Case Top Assembly **1029140**

Handle	9710002
Meter	9400005
Meter Window	9400011
Meter Support Bracket Assembly	9850002
MHV Connector	9782001
Probe Clip	9460004

Case Bottom Assembly **1029050**

Miscellaneous

	Battery, 9V alkaline,	MN 1604		9750001
R45	Potentiometer		20k	9382031
	Cable, Probe,	MHV-MHV,	36-inch	9801001
	Knob; Round, w/pointer			9777001
	Knob, Function			9770003
	Knob, Round			9770004
	Guard, Round Knob			9100034
	Manual, Technical			1029900
	Spare Parts List			1029910
	Schematic Circuit Diagram			1029920
	QC Acceptance Procedure			1029930

Spare Parts List **1029910**

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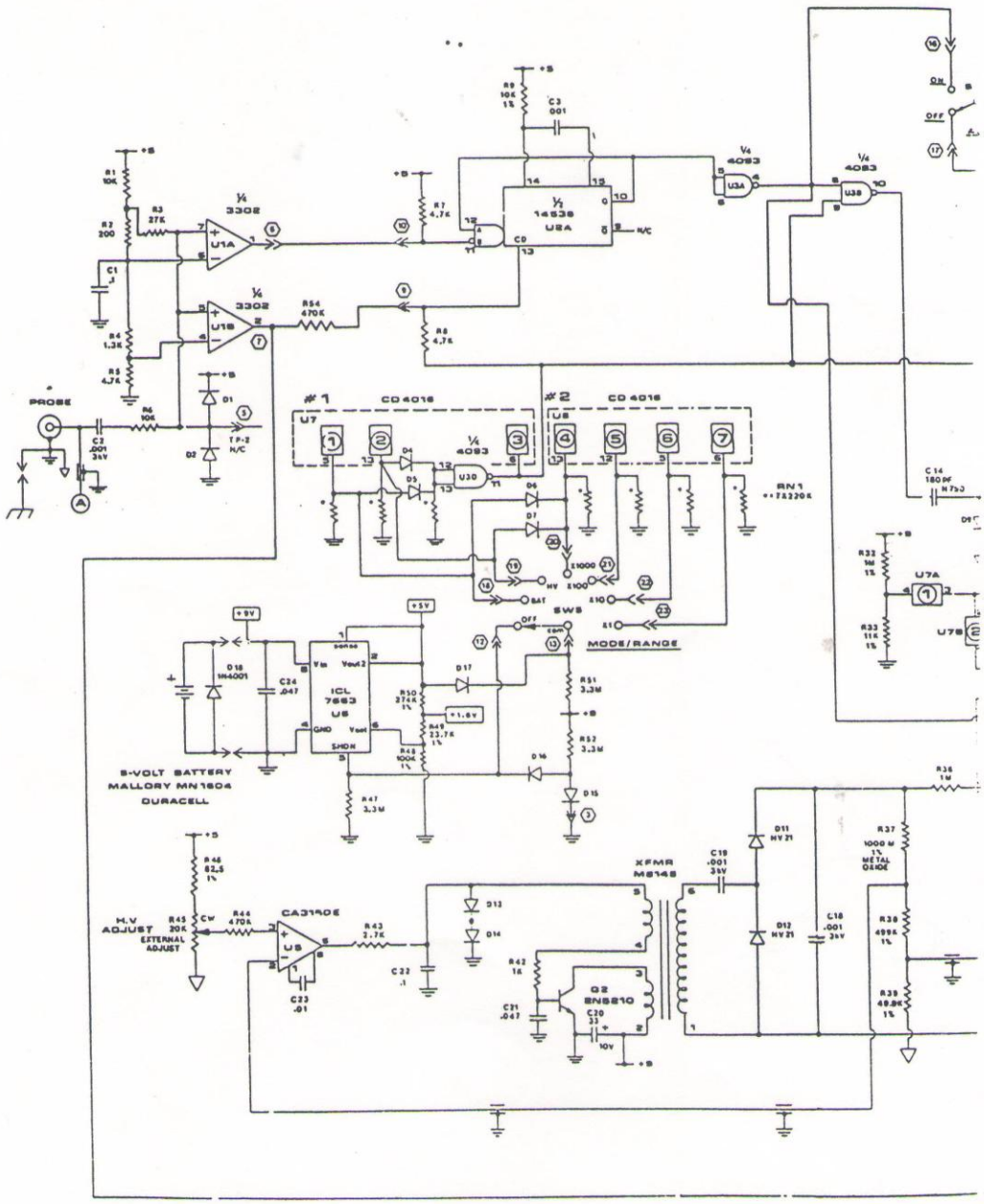
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#2 CD4016
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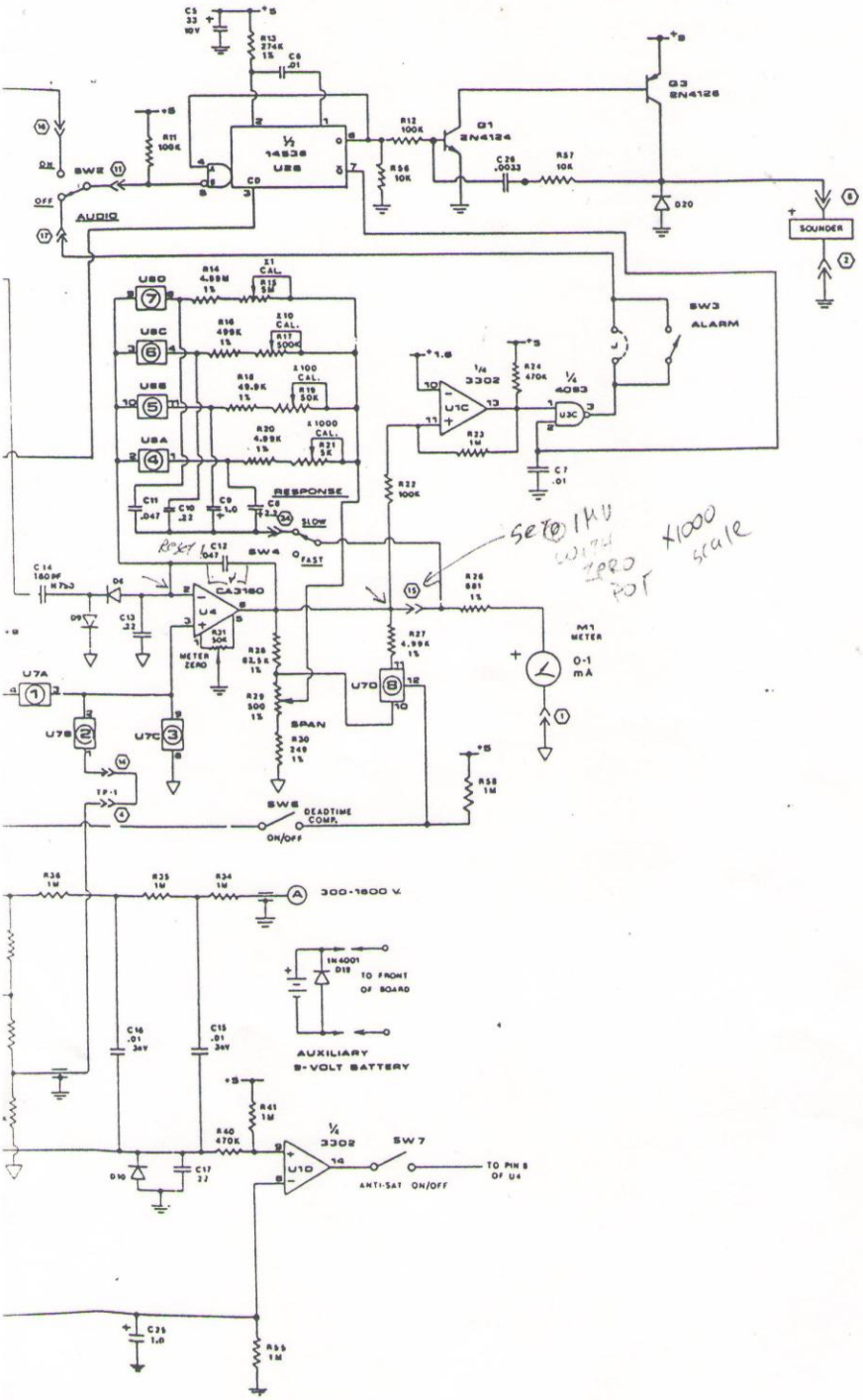
SWS
9-VOLT BATTERY
MALLORY MN1604
DURACELL
H.V ADJUST
EXTERNAL ADJUST
XFMR
MB148
Q2
2N5210
ICL 7663 US
CA3140E



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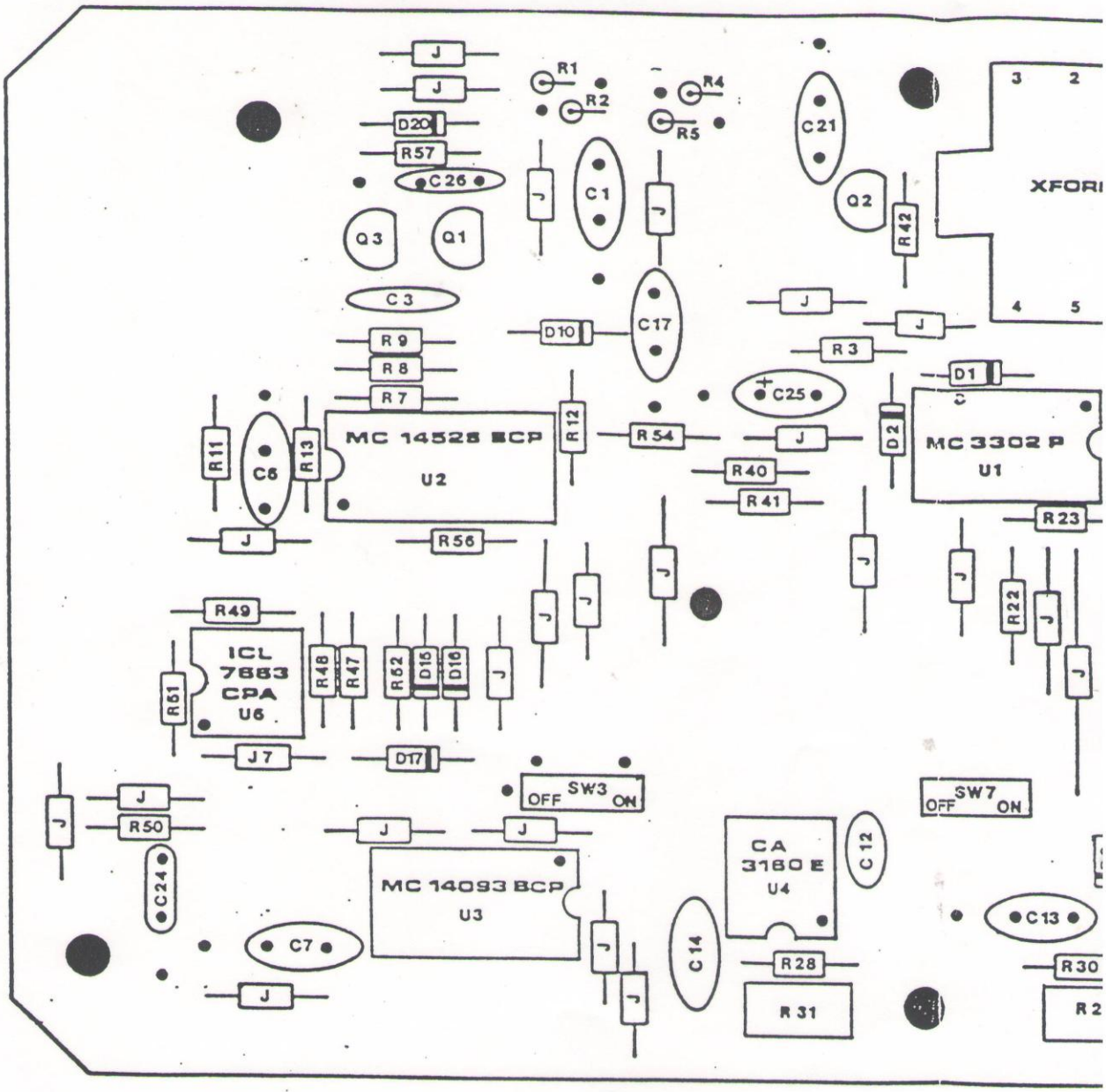

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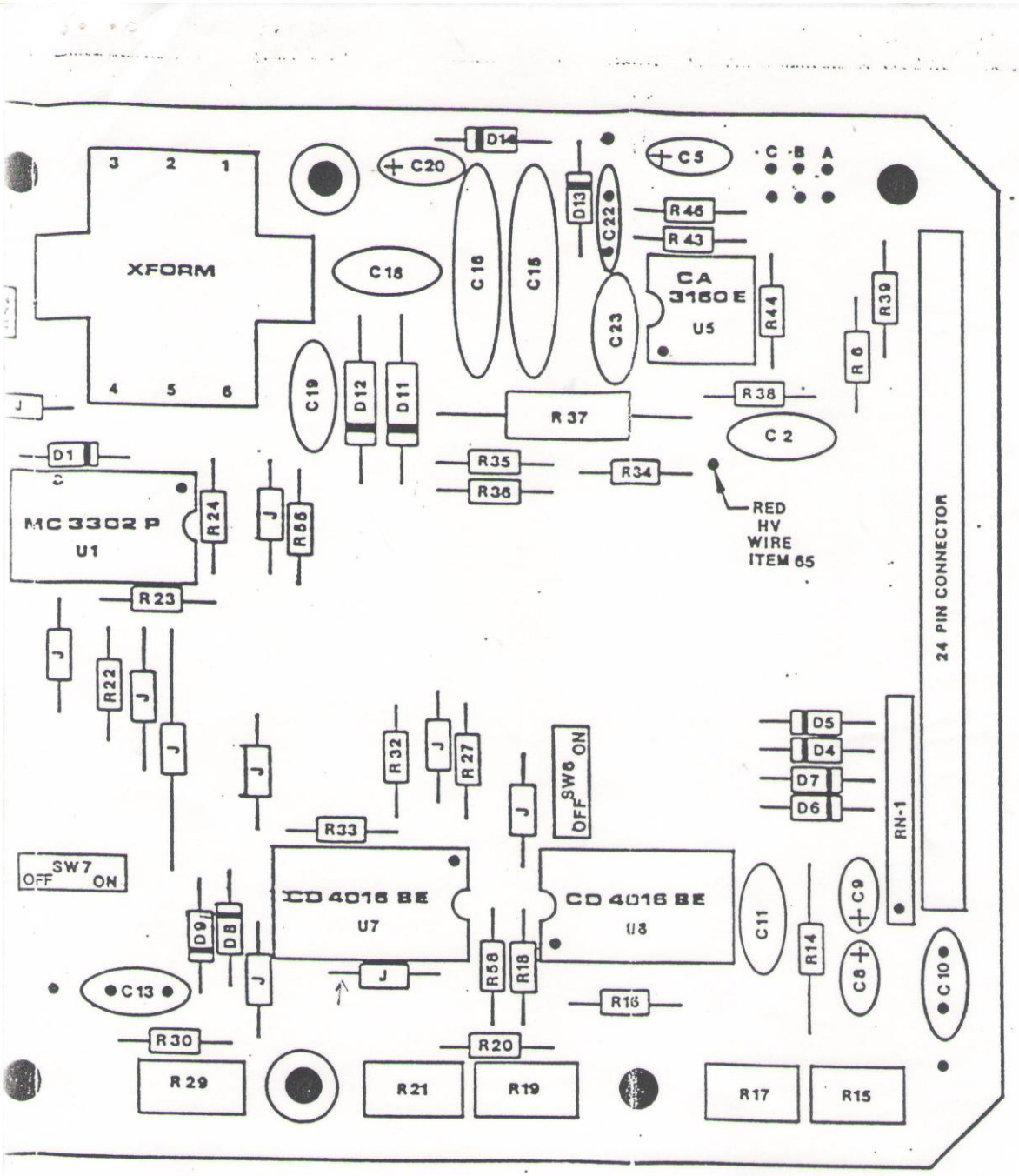

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	FINISH SPEC.		SURVEYOR 'M'
URR & BREAK LL EDGES		DRWG. NO. D1029010	REV.

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